

SYSTEMATICS OF *KIMIA*, A NEW GENUS OF SABETHINI (DIPTERA:
CULICIDAE) IN THE ORIENTAL REGION

RALPH E. HARBACH, VU DUC HUONG, AND IAN J. KITCHING

(REH, IJK) Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, U.K. (e-mail: r.harbach@nhm.ac.uk); (VDH) Department of Entomology, National Institute of Malariaology, Parasitology and Entomology, Luong Thé Vinh Street, BC10.200 Tu Liem, Hanoi, Vietnam

Abstract.—*Kimia Vu Duc Huong and Harbach, n. gen.*, a small homogeneous group of mosquitoes of tribe Sabethini from eastern areas of the Oriental Region, is described and diagnosed based on shared morphological features observed in the adult, larval, and pupal stages of five species, all of which were previously included in subgenus *Snaymyia* Thurman of genus *Topomyia* Leicester. Generic status of *Kimia* is supported by a cladistic analysis of morphological data, as well as data not included in the analysis, that indicate a relationship with New World *Trichoprosopon* and Old World *Tripteroides*. Salient differences that distinguish *Kimia* and *Topomyia* are contrasted. Nominal species belonging to *Kimia* include *Topomyia decorabilis* Leicester, *Topomyia imitata* Baisas, *Topomyia miyagii* Toma, *Topomyia nemorosa* Gong, and *Topomyia suchariti* Miyagi and Toma. The lectotype of the type species, *Kn. decorabilis*, is designated. The adults, pupa, and unique larva of the type species are described and its male genitalia, pupa, and larva are illustrated. The systematics, bionomics, and distribution of the genus and type species are discussed.

Key Words: *Kimia decorabilis*, *imitata*, *miyagii*, *nemorosa*, *suchariti*, mosquitoes, new genus, phylogeny, Sabethini

Tribe Sabethini includes 414 currently recognized species that occur principally in tropical and subtropical areas of the world. The species are placed in 13 genera, nine in the New World (221 species) and four in the Old World (193 species). Although the tribe as a whole has received relatively little attention, the imbalance in the number of genera recognized in the two hemispheres suggests that the sabethine fauna of the Old World has been neglected in comparison with that of the New World. As noted by Belkin (1962), the majority of Old World species, “except for the few aberrant and specialized forms placed in *Malaya*,

Topomyia, and *Maorigoeldia*, ...are placed in the rather generalized genus *Tripteroides*.” Of the Old World species, 12 are placed in genus *Malaya* Leicester, one in genus *Maorigoeldia* Edwards, 57 in genus *Topomyia* Leicester, and 122 in genus *Tripteroides* Giles. Five of the species placed in *Topomyia* clearly represent a separate phyletic line based on unique characteristics of the larval and pupal stages, as well as features of the male genitalia, and are herein recognized as constituents of a new genus. These species include *To. decorabilis* Leicester, *To. imitata* Baisas, *To. miyagii* Toma, *To. nemorosa* Gong, and *To. suchariti*

Miyagi and Toma. It is interesting to note that Edwards (1922) found the adults of *To. decorabilis* "so distinct from the others [other species of *Topomyia*] that it might almost be placed in a separate genus." The immature stages of mosquitoes were either unavailable or largely neglected by taxonomists prior to World War II, but had Edwards studied the larva and pupa of *To. decorabilis* he probably would have proposed a new genus for this species. The new genus established below is typified by *To. decorabilis* and supported by a cladistic analysis of morphological data, as well as diagnostic features not included in the analysis.

MATERIALS AND METHODS

Morphological structures were examined in the adult, pupal, and fourth-instar larval stages. The principal material examined, including the type specimens of *To. decorabilis*, are deposited in The National History Museum (NHM), London. Some specimens collected by Vu Duc Huong and colleagues in various provinces in northern Vietnam between 1979 and 1982 (see Material examined below) reside in the Culicinae collection of the National Institute of Malariology, Parasitology, and Entomology (NIMPE), Hanoi. Diagnostic and differential characters were confirmed in all specimens examined. Observations of adult mosquitoes were made under simulated natural light. Larval and pupal stages and male genitalia were studied using differential interference contrast microscopy. Unless indicated otherwise, numbers in parentheses represent modes of the reported ranges. Morphological terminology follows Harbach and Knight (1980, 1982) and Harbach and Kitching (1998). Life stages of material examined are indicated by the symbols ♂ (male), ♀ (female), L (fourth-instar larva), Le (larval exuviae), and Pe (pupal exuviae). The letter G (genitalia) is used in combination with the male symbol.

The phylogenetic relationships of *Kimia* with other sabethine genera were examined by including character data for *Kimia* in the data set of Harbach and Kitching (1998), as modified by Harbach and Peyton (2000) to include genus *Onirion* Peyton and Harbach, and then subjecting the combined data set to an implied weights parsimony analysis using PIWE version 3.0 (for Windows) (Goloboff 1997). Forty-four genera (42 of Harbach and Kitching + *Onirion* and the new genus described herein) were coded for 73 characters (Appendix). Genera that were polymorphic for different states of a character were explicitly coded as possessing all those states. All multistate characters were treated as unordered. The PIWE commands amb-, hold 100,000, hold/50, mult*5,000 were used and the concavity constant was set to 1 to down weight the most homoplastic characters as much as possible, in line with previous analyses. It was not found necessary to swap further the cladograms found by "mult" by using the command max*.

TAXONOMIC TREATMENT

Kimia Vu Duc Huong and Harbach, new genus

Type species: *Topomyia decorabilis* Leicester 1908, Malaysia.

Topomyia in part of Edwards 1922: 437–440, pl. VIII (*decorabilis*); Baisas 1946: 32–39, 43 (*imitata*); Edwards 1932: 63, 67, 69, 89–91 (*decorabilis*); Mattingly 1971: 12, 15, 23, 29, 32, (35, unspecified reference to *decorabilis*, *imitata*), pl. 9 (*decorabilis*), pl. 26 (*decorabilis*?); Rattanarithikul and Panthusiri 1994: 36, 51; Harbach and Sandlant 1997; Harbach and Kitching 1998: 333, 335, 344, 346, 350, 352, 359–361; Harbach and Peyton 2000: 165–167; Rueda et al. 1998; Huang 2002: 2, 22; White et al. 2004.

Topomyia (*Suaymyia*) in part of Thurman 1959: 44–45 (*decorabilis*, *imitata*);

Stone et al. 1959: 95–96 (*decorabilis*, *imitata*); Knight and Stone 1977: 310 (*decorabilis*, *imitata*); Tsukamoto et al. 1985: 156 (*imitata*); Ward 1992: 204 (*suchariti*); Harbach and Peyton 1993: 2, 4, 8 (*imitata*); Judd 1996: 132, 137–139, 141; Judd 1998: 68–75.

Adults.—Sexes essentially identical in body size and outward appearance. Medium-sized mosquitoes with broad flat scaling on head capsule, thoracic pleura, scutellum, coxae and abdomen; anterior triangular area of vertex, posterior area of antepronotum, median longitudinal stripe (acrostichal area) on scutum and median anterior area of scutellum with metallic silvery white scales; longitudinal silver stripe of scutum comprised of 2 rows of broad rounded spatulate scales emanating from midline; broad lateral areas of scutum with dense covering of dark narrow falcate scales that become noticeably larger and intermixed with dark setae on supraalar area and at sides of prescutellar area; lobes of scutellum with dark broad flat scales and several long dark stout setae; scales of postgena, thoracic pleura and coxae metallic silver to gold, mainly gold, similar scales on pre- and postprocoxal membranes; legs dark-scaled, ventral surfaces of femora narrowly pale-scaled; wing entirely dark-scaled, alula with fringe of rather long piliform scales; abdominal terga primarily dark-scaled, lateral margins and sterna with yellow to gold scaling (sternum VIII of female dark-scaled).

Females.—*Head*: Eyes joined above and below. Occiput without transverse row of erect scales at back of head. Ocular setae dark, conspicuous, close to margin of eye; 2 long, dark, approximated interocular setae present. Interantennal ridge incomplete, frontal pit reinforced by cuticular ring associated with postfrontal sutures. Antenna slightly shorter than proboscis; pedicel large,

surface pubescent, with inconspicuous setae and scales on dorsomesal surface, basomesal microsetae present; flagellum moderately verticillate, whorls with 8–10 setae, longest setae about twice length of corresponding flagellomere. Clypeus without setae and scales, with dense covering of silvery pubescence. Proboscis straight or slightly bent and slightly expanded distally, slightly longer than antenna, slightly shorter than forefemur; labellum comprised of 2 sclerites of similar size, proximal sclerite with scales. Maxillary palpus short, with 2 palpo-meres. *Thorax*: Integument brown; setae present on antedorsocentral area, supraalar area, lateral prescutellar area, posterior margin of scutellum, anterior surface of antepronotum, posterior margin of postpronotum, and upper proepisternal, prespiracular, prealar, lower mesokatepisternal and upper mesepimeral areas; paratergite and mesopostnotum bare. Lower proepisternum without scales, scales on upper proepisternum contiguous with scales on ante- and postprocoxal membranes; mesopleuron with scales except on lower anterior margin of mesokatepisternum, posterior margin of mesepimeron and mesomeron; large patch of scales below spiracle on metapleuron, absent on metameron. *Wing*: Dark-scaled; alula with piliform scales on margin; calypters without setae; cell R_2 much longer than vein R_{2+3} ; anal vein ends well beyond junction of mcu and CuA . *Halter*: Scabellum bare, integument pale; pedicel and capitellum dark-scaled. *Legs*: Coxae and trochanters with golden scales, trochanters with dark scales dorsally at apex; femora, tibiae and tarsi dark-scaled, femora narrowly pale ventrally. Forefemur slightly longer than proboscis, slightly longer than mid- and hindfemora; foretarsomere 1 shorter than foretarsomeres 2–5 combined. Ungues small, simple. *Abdomen*: Coloration as noted above, lateral pale areas of terga usually round-

ed, especially on more posterior segments; sternum IX without setae and scales.

Males.—Like female except for sexual characters. *Legs*: Foretarsomere 5 elongate C-shaped in lateral view, with basal inner lobe bearing specialized setae; foreungues unequal, inner unguis larger, with lobe(s) or denticle(s). *Genitalia*: Tergum and sternum IX articulated laterally; tergum IX lobes widely separated, elongate, columnar, each lobe with short curved bladlike seta at apex and group of lanceolate setae on mesal side of base, latter setae nearly as long as lobe. Gonocoxite elongate, tapered distally, tergomesal surface membranous, sternal and lateral surfaces with setae and scales; basal mesal lobe with 2 or more long rodlike or otherwise specialized setae. Gonostylus without accessory lobes, with prominent simple setae on sternal surface and gonostylar claw at apex. Aedeagus formed of two plates with digitiform sternal and tergal arms. Proctiger with long slender tapered paraproct and basal sclerotization (tergum X) articulated with tergum IX at base of tergal lobe; cercal setae absent.

Pupae.—*Cephalothorax*: Dorsal apotome long, weakly sclerotized medially, seta 1-CT strongly developed, long, usually double; 3,4,7-10-CT usually single. *Trumpet*: Short, cylindrical; pinna essentially absent; supporting tubercle and tracheoid area absent. *Abdomen*: Seta 1-I well developed, moderately long, dendritic, 1-II mesal to seta 2, 1-III mesal or lateral to seta 2, 1-IV-VI lateral to seta 2, 1-VII closely associated with and usually mesal to seta 1, 1-IX absent; 2-II-VII near posterior margin of tergum, 2-IV-VI mesad of other dorsal setae; 3-I usually mesal to seta 2, 3-III not longer than 3 on following segments; 5-II,VI,VII weakly developed, 5-II single, 5-VI,VII single or multiple-branched, 5-III-V strongly developed, long, normally single; 6-II-VI similarly developed,

short, usually single or double, inserted dorsomesal and usually slightly anterior to seta 9, 6-VII strongly developed, similar to seta 9, inserted anterior to seta 9; 7-I slightly if at all longer than seta 6; 9-II-VI minute, inserted posterolaterally at very edge of ventral surface, 9-VII,VIII very strongly developed, fanlike with aciculate branches, 9-VII inserted dorsally near posterolateral corner of segment, 9-VIII inserted ventrally in same location; 10-II present; 14-III-VIII absent; punctures III-V absent. *Paddle*: Short, much shorter than seta 9-VIII; tapered in distal half, margins spiculate; asymmetrical, outer part broader than inner part; setae 1,2-Pa absent.

Larvae, fourth-instars.—*Head*: Slightly if at all wider than long, somewhat square in dorsal view. Occipital foramen more or less oval, midventral angle extended anterior to posterior tentorial pit (PTP), bounded by ill-defined collar. PTP at margin of collar. Hypostomal suture long but normally ending short of PTP. Dorsomentum short, triangular, median tooth slightly longer than others. Maxilla elongate, maxillary body, hypostomal sclerite and maxillary palpus separate components; maxillary brush represented by an articulated rigid bundle of coalesced spicules (maxillary bundle), apical tooth stout, rigid, tapered, slightly bent mesad, about half length of maxillary bundle; laciniarastrium composed of long flexible spicules; seta 3-Mx strongly developed, long, projecting orally. Seta 1-C strongly developed, stout; 4-7,14-C normally single, 4-7-C slender, simple, 14-C stout, spinelike; 8-C slightly posterior and 9-C far posterior to 10-C; 11-13-C close-set near anterior margin of head capsule adjacent to base of antenna. *Antenna*: Short, cylindrical; seta 1-A short, single, borne dorsally about 0.7 from base. *Thorax*: Seta 0-P mesal to 4-P, near 1-P; 9-P well developed, with numerous branches; 8-M absent (seta 13-M labelled incorrectly as 8-M in Miyagi

and Toma's (1989) illustration of *Km. suchariti*); 3-T small, with numerous filamentous branches; 8-T dorsal to plate bearing 9–13-T; 13-T inserted mesally on plate shared with 9–12-T. *Abdomen*: Seta 1-I weakly developed, mesad of seta 2, 1-II–VII progressively more strongly developed, laterad of seta 2; 2-I anterolaterad of seta 1, 2-II–VII well anteromesad of seta 1; 3-I moderately long, 3-I–III, V single or branched, 3-IV, VI branched, 3-VII always single, relatively longer than others, inserted lateral to seta 5; seta 5-VII weakly developed, 5-I–V normally single or double, 5-VI, VII usually double or triple; 6-I–V relatively short, mainly shorter than length of segment, 6-I, III–V branched, 6-II, VI single, 6-VI very long, much longer than others; punctures absent from segments III–V. *Segment VIII*: Comb plate absent; scales in irregular single row, thornlike. Seta 3-VIII strongly developed, multiple branched; 4-VIII inserted anterior to 5-VIII. *Siphon*: Widest at base, gradually narrowed to apex; pecten absent; anterior and posterior margins each beset with 2 close-set rows of off-set strongly developed setae. *Segment X*: Saddle relatively small, extending to lateral midline of segment. Setae 1–3-X strongly developed, 1-X very long, inserted on posterolateral corner of saddle; setae 2, 3, 4-X fanlike with numerous simple branches, 4-X of opposite sides borne on common ventrocaudal plate.

Eggs.—Unknown.

Included species.—*Kimia decorabilis* (Leicester 1908), *Km. imitata* (Baisas 1946), *Kn. suchariti* (Miyagi and Toma 1989), *Km. nemorosa* (Gong 1996), and *Km. miyagii* (Toma and Mogi 2003).

Etyymology.—This genus is dedicated to Tran Thi Bach Kim, medical biologist and wife of the second author of this paper, Dr Vu Duc Huong, who recognized *Kimia* as a new genus more than 25 years ago. Kim is honored for assisting her husband's work over a period of

nearly 40 years. It is befitting that Kim in old Vietnamese means “new” or “present”. Kim is also the first syllable of the old Vietnamese word *kim ngan* and the second syllable of *bach kim*, which mean “jewellery” and “platinum”, respectively. *Kimia* is a feminine generic name. In keeping with the practice initiated by Reinert (1975), the two-letter abbreviation *Km.* is recommended for this genus.

Systematics.—Analysis of the data set under implied weighting generated three most parsimonious cladograms (MPCs) with fit = 288.0 (29%). The inclusion of character data for *Kimia* in the data set of Harbach and Peyton (2000) did not alter relationships of the non-sabethine genera, therefore only the Sabethini clade from the strict consensus tree of the three MPCs is illustrated here (Fig. 1), with Bremer and relative Bremer support values (Fig. 1A) and supporting characters (Fig. 1B) indicated on the branches.

The inclusion of *Kimia* in the analysis produced a very different pattern of relationships among sabethine genera than that recovered by Harbach and Kitching (1998) and Harbach and Peyton (2000). Contrary to the findings of these authors, and Judd (1996), the New World genera of Sabethini are not recovered as a monophyletic clade in a derived relationship to the Old World genera. The New World genus *Trichoprosopon* Theobald is paired with the Old World *Tripteroides* in a sister relationship with *Kimia*, and the Old World *Malaya*, which was sister to *Topomyia* in previous analyses, is placed as sister to the New World *Limatus* (Fig. 1). Although the depicted relationships are generally weakly supported, they are no less tenable than the relationships recovered in the earlier studies. Although the sister-group relationship between *Kimia* + (*Trichoprosopon* + *Tripteroides*) is not strong (Bremer support 0.2;

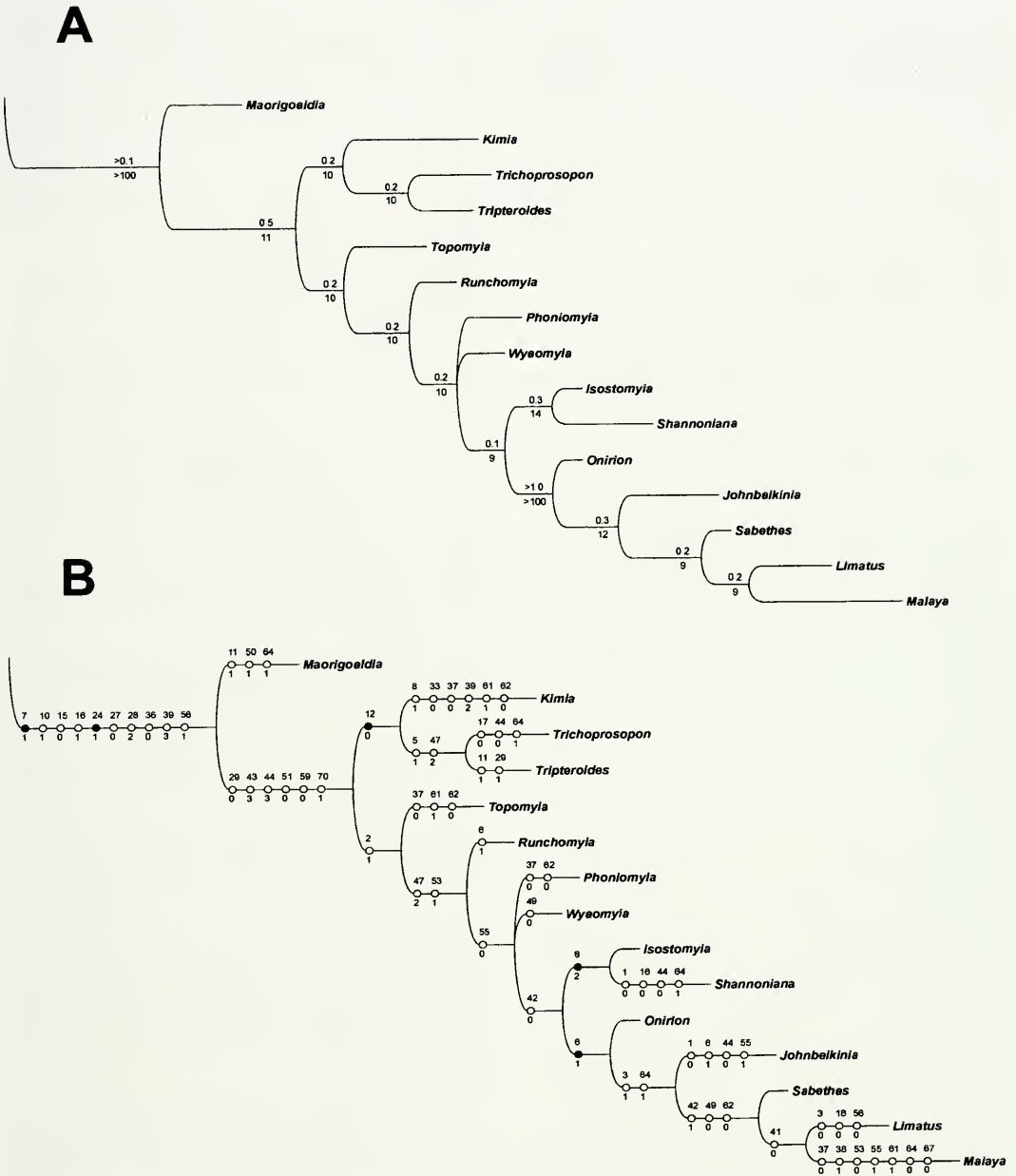


Fig. 1. Topology of the Sabethini clade with character data for *Kimia* included in the data set of Harbach and Peyton (2000). A, Strict consensus tree of three MPCs (Fit = 288.0) obtained from the analysis of the data under implied weights. Bremer support and relative Bremer support values of each clade are indicated above and below the branches, respectively. B, Same with unambiguously optimized supporting characters mapped onto the branches.

relative Bremer support 10), it is supported by a single unique character (12:0, absence of larval seta 8-M) that is not contradicted. Of the six homoplastic

characters that diagnose *Kimia*, two (33:0, absence of pupal setae 14-VIII, and 39:2, interantennal ridge of females incomplete with frontal pit reinforced by

a cuticular ring associated with the postfrontal sutures) are unique within tribe Sabethini. It should be evident that the characters included in the cladistic analysis determine the relationships portrayed in Fig. 1. A number of morphological characters not included in the analysis (see below) further corroborate the uniqueness of *Kimia* and its similarities with *Trichoprosopon* and *Tripteroides*.

It is obvious that species of *Kimia* were placed in genus *Topomyia* based principally on the ornamentation of adults. Despite the striking similarity in adult habitus, *Kimia* and *Topomyia* do not appear to be closely related. The many characteristics that distinguish these genera are listed in Table 1. The larvae and pupae of the two genera share a number of features but are quite distinct overall. The presence of an oval occipital foramen in larvae suggests that *Kimia* most likely share affinities with the Old World *Tripteroides* and the New World *Shannoniana* Lane and Cerqueira, *Johnbelkinia* Zavortink, and *Trichoprosopon*. The absence of larval seta 8-M in *Kimia*, *Trichoprosopon*, and most species of subgenus *Tricholeptomysia* Dyar and Shannon of genus *Tripteroides* suggests a closer relationship between these taxa. In addition to the similar development of the occipital foramen and absence of seta 8-M in *Kimia* and *Trichoprosopon*, the larvae of these two genera also lack a pecten and have seta 13-T inserted on a plate with setae 9-12-T. A pecten is present in *Topomyia* and *Tripteroides* and absent in *Johnbelkinia* and *Shannoniana*. The insertion of seta 13-T and setae 9-12-T on a common plate in *Kimia* and *Trichoprosopon* is a unique feature among sabethine genera.

The absence of setae on the upper calypter of the wing and the presence of a median longitudinal stripe of silvery scales on the scutum have been used as key characters to distinguish the adults

of *Topomyia* from those of *Tripteroides* (e.g., Thurman 1959), and there is no doubt that these features in *Kimia* resulted in the placement of these species in *Topomyia*. A median longitudinal stripe of silvery scales is not unique to species of *Topomyia* or *Kimia*. A similar stripe is also present in some species of *Malaya*. As Belkin (1962) suggested, "*Malaya* appears to be an ancient derivative from a generalized sabethine stock which also gave rise to *Topomyia*." *Malaya* species also do not have setae on the upper calypter. In contrast, species of the New World genera mentioned above do not have a longitudinal stripe on the scutum. Whereas all species of *Johnbelkinia* and *Shannoniana* have setae on the upper calypter, these setae are absent in some species of *Trichoprosopon*, which is not inconsistent with a possible affinity with *Kimia*.

In some respects, the male genitalia of *Kimia* bear a closer resemblance to those of *Tripteroides* than to species of *Topomyia*, especially in the shape of the basal mesal lobe and its association with the gonocoxite. The basal mesal lobes of *Kimia* and *Tripteroides* (*Tripteroides*) are crescent-shaped with the distal part produced, not joined to one another, and incompletely separated from the gonocoxite. They are similarly shaped but separated from the gonocoxite in *Johnbelkinia*, *Shannoniana*, and *Trichoprosopon*.

Whereas punctures are present on two or three of segments III-V in pupae of *Johnbelkinia*, *Topomyia*, and *Tripteroides*, they are entirely absent in *Kimia*, *Trichoprosopon*, and *Shannoniana*. Seta 6-VII is strongly developed and inserted anterior to 9-VII in pupae of *Kimia* and *Malaya*. This seta, although not strongly developed, is also inserted anterior to 9-VII in *Trichoprosopon* and subgenera *Polylepidomyia* Theobald, *Rachionotomyia* Theobald, *Rachisoura* Theobald, and *Tripteroides* of genus *Tripteroides*.

Table 1. Salient anatomical differences that distinguish the adults, pupae, and fourth-instar larvae of *Kimia* and *Topomyia*.

Character	<i>Kimia</i>	<i>Topomyia</i>
Adult females		
Sternum IX	Without setae and scales	With setae and scales ¹
Adult males		
Foreungues	Inner larger, with lobe(s) or denticles(s)	Equal, simple
Foretarsomere 5	C-shaped in lateral view, with basal inner lobe bearing specialized setae	More or less cylindrical, without basal lobe
Basal mesal lobe	Crescentic, produced distally, incompletely separated from gonocoxite, not joined with its mate	Irregularly shaped plaque or lobed structure, distinctly separated from gonocoxite, narrowly joined with its mate
Cercal setae	Absent	Present
Aedeagus	Broad, short	Narrow, elongate
Pupae		
Seta 1-VII	Usually mesal to 2-VII	Lateral to 2-VII
Setae 2,3-X	Highly branched, 3-X not longer than siphon	With fewer branches, usually longer than siphon
Seta 3-I	Usually mesal to 2-I	Lateral to 2-I
Seta 3-III	Short, weaker than 5-IV, similar to 3 on following segments	Usually long, similar to 5-IV, more strongly developed than 3 on following segments
Seta 5-III	Long, similar to 5-IV,V	Short, dissimilar to 5-IV,V
Seta 5-VI	Short, much weaker than 5-IV,V, similar to 5-VII	Long, similar to 5-IV,V, much stronger than 5-VII
Seta 6-VII	Strongly developed, similar to 9-VII, inserted far anterior to 9-VII	Weakly developed, much smaller and inserted immediately mesal to 9-VII ²
Seta 10-II	Present	Usually absent
Seta 14-VIII	Absent	Present
Punctures III-V	Absent	Present or absent of III, present on IV and V
Larvae		
Occipital foramen	More or less oval	Transverse, slitlike
Seta 8-C	Slightly posterior to 10-C	Anterior to 10-C
Seta 9-C	Far posterior to 10-C	Level with to slightly anterior to 10-C
Seta 11-13-C	Close together near margin of head capsule	More widely separated and removed from anterior margin of head capsule
Seta 3-Mx	Strongly developed, prominent	Otherwise
Seta 0-P	Mesal to 4-P, near 1-P	Posterior to 4-P, far from 1-P
Seta 9-P	With numerous branches	With fewer branches
Seta 8-M	Absent	Present
Seta 3-T	With numerous branches	With fewer branches
Seta 8-T	Dorsal to 9-13-T	Dorsal to 7-T
Seta 13-T	On plate with 9-12-T	Not on plate with 9-12-T
Seta 3-VII	Lateral to 5-VII	Mesal to 5-VII
Seta 3-VIII	Strongly developed, with numerous branches	Weaker, with few branches
Seta 4-VIII	Anterior to 5-VIII	Posterior to 5-VIII
Seta 4-X	Highly branched	With fewer branches
Seta 6-I-V	Short, mainly shorter than length of segment	Long, much longer than length of segment
Seta 6-VI	Much longer than 6-I-V	As long or shorter than 6-I-V
Pecten	Absent	Present
Siphon setae	Numerous, long, highly branched	Variable, never as long, numerous or highly branched

¹ Except *To. yanbarensis* (see Lu Baolin et al. 1997).² Except *To. malaysiensis* where 9-VII is slightly lateral but far anterior to 6-VII.

It is moderately to strongly developed and inserted anterior and lateral to 9-VII in species of *Johnbelkinia*. The long seta 5-III and short seta 5-VI distinguish the pupae of *Kimia* from those of *Topomyia* and *Tripteroides* in which 5-III is short and 5-VI is long. These setae, as well as their homologs on segments VI and V, are weak and short on *Trichoprosopon* pupae. Seta 5-III is well developed in *Johnbelkinia* and *Shannoniana*. Whereas seta 14-III-VII is present in *Tripteroides*, it is absent in *Kimia*, *Malaya*, *Topomyia*, and the New World *Johnbelkinia*, *Shannoniana*, and *Trichoprosopon*. The absence of pupal seta 14-VIII in *Kimia* is a unique feature within Sabethini; in fact this seta is present in all other Culicidae except for some species of *Toxorhynchites* Theobald.

Detailed comparative analysis of the known species of *Kimia* is limited by a paucity of available specimens. Except for *Km. decorabilis* (see below), nominal species of the genus are known only from a holotype (*Km. imitata* and *Km. suchariti*) or a holotype and a number of paratypes (*Km. miyagii* and *Km. nemorosa*) from or near the type locality. Based on published illustrations of male genitalia, it appears that *Km. nemorosa* may be a junior synonym of *Km. suchariti*. In depth study of all life stages of these two nominal forms is required to determine whether they represent the same or different species.

Bionomics.—Little bionomical information is available for species of *Kimia*. Adult and pupal stages have never been collected in the wild and are known only from laboratory rearings of larvae found in bamboo stumps and erect bamboo internodes bearing small holes presumably made by beetles. It is uncertain whether larvae are facultative or obligatory predators. The maxillae appear to be modified for grasping. Before reaching the pupal and adult stages, the holotype of *Km. suchariti* was seen to

prey on larvae of *Armigeres* Theobald and *Tripteroides* (Miyagi and Toma 1989). Larvae of *Stegomyia aegypti* (Linnaeus) (= *Aedes aegypti* prior to Reinert et al. 2004) were used as a source of food while rearing the larvae of *Km. decorabilis* that were collected in northern Vietnam in 2005 for the present study (see Bionomics of *Km. decorabilis* and Material examined below).

Distribution.—Species of *Kimia* are only definitely recorded from China (Yunnan Province, *Km. nemorosa*), Indonesia (Flores, *Km. miyagii*), peninsular Malaysia (Perak and Selangor states, *Km. decorabilis*), Philippines (Mindanao, *Km. imitata*), Thailand (Chanthaburi Province, *Km. suchariti*), and northern Vietnam (Bac Kan, Bac Thai, Ha Son Binh, Ha Tuyen, Hoang Lien Son, Thai Nguyen, and Thanh Hoa provinces, *Km. decorabilis*). Edwards (1932), and subsequently Stone et al. (1959) and Knight and Stone (1977), indicated that *Km. decorabilis* also occurs on Borneo, but the source of this record is unknown and requires confirmation.

Kimia decorabilis (Leicester)

(Figs. 2-4)

1908. *Topomyia decorabilis* Leicester 1908: 239 (♂, ♀). Lectotype ♂, hereby designated to fix the application of the specific name, bearing the following original data: "In jungle/The Gap [Selangor, Malaysia]/24/4/04" (NHM), **n. comb.** The specimen bears a label indicating lectotype selection by T.J. Zavortink, but the intended selection was never formally fixed by publication.

Female.—As described for genus. *Head*: Antenna dark; length about 2.0 mm, slightly shorter than proboscis; flagellomere 1 slightly swollen, with some slender scales among setae. Proboscis slightly bent and slightly expanded distally; length about 2.3 mm, slightly

longer than antenna, about 0.9 length of forefemur; with 2 or 3 basal labial setae. Maxillary palpus about 0.1 length of proboscis; dark-scaled. *Thorax*: Integument light brown. Antedorsocentral, anteprenotal, supraalar and scutellar setae strong, conspicuous, dark; lateral prescutellar setae similar but less conspicuous; antealar area with lateral line of golden spatulate scales that partially project over paratergite; prescutellar area small, sometimes with short lateral lines of silver spatulate scales contiguous with spot of similar scales on median anterior area of scutellum. Postpronotal, upper proepisternal, prespiracular and prealar setae dark; lower mesokatepisternal and upper mesepimeral setae pale. *Wing*: Length 3.5–4.2 mm; decumbent spatulate scales on all veins except semierect fusiform scales on dorsal surface of R_s and M . *Legs*: Forefemur about 1.1 length of proboscis.

Male.—As described for genus; like female except for sexual differences. *Genitalia* (Fig. 2C–E): Tergum VIII (ventral in position) (not figured) with posterior cluster of long setae that decrease in number and length laterally. Tergum IX lobe with group of 2–5(3) lanceolate setae at mesal side of base; sternum IX broadest in middle, progressively narrowed laterally, posterior margin evenly rounded, without setae and scales. Gonocoxite tapered distally, lateral setae strongly developed, a group of relatively long setae distally on mesal surface near base of gonostylus; basal mesal lobe separated from gonocoxite by narrow membranous area for most of length, contiguous with gonocoxite proximally, apex with 2 long rodlike setae and a slightly longer thickened or lanceolate seta that reach beyond apex of gonocoxite, with group of shorter setae on tergomesal surface at base of 3 long apical setae. Gonostylus short, about half length of gonocoxite, bent, slightly twisted and projecting tergomesad over

lateral side of basal mesal lobe, slightly flattened and tapered distally, sternal surface lined with short simple setae, peglike gonostylar claw at apex. Aedeagus slightly longer than wide, resembling a cupped human hand in lateral view, with long slightly tergally curved sternal arm (forefinger) and shorter mesally bent tergal arm (thumb), sternal arms well separated, tergal arms meet at midline. Proctiger with long tapered paraproct and heavily sclerotized tergum X, tergum X narrowly fused with base of paraproct and articulated with tergum IX at base of tergum IX lobe.

Pupa (Fig. 2A,B).—As described for genus; character and positions of setae as figured, numbers of branches in Table 2. *Cephalothorax*: Moderately tanned, with mottling of slightly darker areas on dorsum. Seta 1-CT usually double, branches nearly straight, hooked apically; 3,7,8,10-CT usually single, 4,9-CT always single; 13-CT or its alveolus usually present, single when developed. *Trumpet*: Moderately tanned, yellow compared to brown scutum; abruptly expanded at base into broad short cylinder; pinna essentially absent; length 0.35–0.52 mm (mean = 0.45 mm), width 0.17–0.23 mm (mean = 0.20 mm), index 1.96–2.48 (mean = 2.74). *Abdomen*: Moderately tanned, terga and sterna progressively paler, especially anteriorly, on successive posterior segments; length 4.2–5.0 mm (mean = 4.6 mm). Seta 1-II frequently double but usually with more than 2 branches, 1-III–VI moderately developed, frequently with 2 or 3 branches; setae 6,7-I relatively long, usually with 3 or more branches, infrequently single; 10-I or its alveolus present, single when present; 8-II usually absent, occasionally alveolus or single seta present; 5-II,VI,VII much smaller than 5-III–V, 5-III–V about length of following tergum. *Genital lobe*: Moderately tanned; length about 0.30 mm in female, about 0.40 mm in male. *Paddle*:

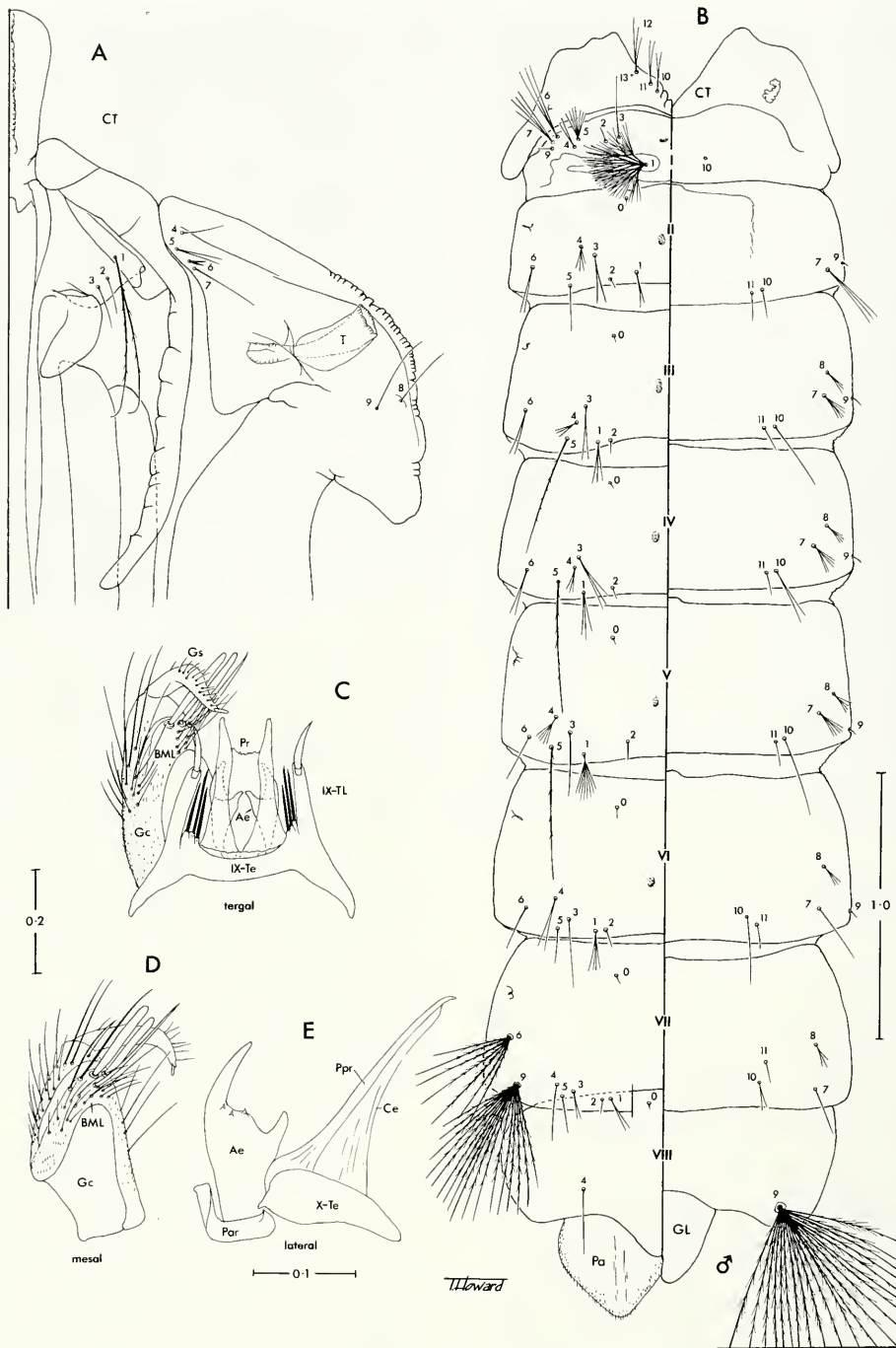


Fig. 2. Pupa and male genitalia of *Kimia decorabilis*. A, B, Pupa: (A) left side of cephalothorax, dorsal to right; (B) dorsal (left) and ventral (right) aspects of metathorax and abdomen. C-E, Male genitalia, aspects as indicated. Ae = aedeagus; BML, basal mesal lobe; Ce, cercus; CT = cephalothorax; Gc = gonocoxite; GL = genital lobe; Gs = gonostylus; Pa = paddle; Par, paramere; Ppr, paraproct; Pr, proctiger; T = trumpet; IX-Te, tergum IX; IX-TL, tergum IX lobe; X-Te, tergum X; I-VIII = abdominal segments I-VIII; 0-11 = setal numbers for specified areas, e.g. seta 5-III. Scales in mm.

Table 2. Numbers of branches for setae of pupae of *Kimia decorabilis*. Range (mode) based on six specimens (12 setae) from Vietnam (3) and Malaysia (3).

Seta	Cephalothorax CT	Abdominal segments									Paddle Pa	
		I	II	III	IV	V	VI	VII	VIII	IX		
0	—	—	1	1	1	1	1	1	1	1	—	—
1	2-5(2)	5-9*	2-6(2)	1-4(3)	1-6(3)	1-7(3)	1-9(4)	1-3(1)	—	—	—	—
2	1,2(2)	1,2(1)	1	1-4(1)	1	1	1	1	—	—	—	—
3	1,2(1)	1,2(1)	1-3(2)	1-3(1)	1-4(3)	1	1,2(1)	1-4(2)	—	—	—	—
4	1	1-3(1)	2-8(5)	1-4(3)	1-3(3)	2-7(5)	1,2(1)	1	1	—	—	—
5	1-3(1)	5-9(5)	1	1,2(1)	1,2(1)	1	1-5(1)	1-4(2)	—	—	—	—
6	1-5(1)	1-5(3)	1-3(1)	1-3(2)	1-3(1)	1,2(1)	1-3(1)	5-12(7)	—	—	—	—
7	1,2(1)	1-7(3)	1-5(3)	2-6(5)	2-6(5)	2-8(5)	1,2(1)	1	—	—	—	—
8	1-3(1)	—	0,a,1(0)†	1-4(1)	1-4(1)	1-4(1)	1-4(4)	1-4(3)	—	—	—	—
9	1	1,2(1)	1	1	1	1	1	13-23(17)	17-26(22)	—	—	—
10	1-3(1)	a,1(a)†	1,2(1)	1,2(1)	1,2(1)	1	1,2(1)	1,2(1)	—	—	—	—
11	1,2(2)	—	0,1(0)†	1	1	1	1	1,2(1)	—	—	—	—
12	1-4(3)	—	—	—	—	—	—	—	—	—	—	—
13	a,1(a)†	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—

* Primary branches. Terminal branches too numerous to count accurately.

† a = represented by alveolus only; 0 = entirely absent.

Moderately tanned; asymmetrical, outer part broader than inner part, inner, outer and apical margins spiculate; length 0.45-0.51 mm (mean = 0.47 mm), width at widest point 0.31-0.42 mm (mean = 0.39 mm), index 1.10-1.65 (mean = 1.24).

Larva, fourth-instar (Figs. 3 and 4).—As described for genus; character and placement of setae as figured, numbers of branches in Table 3. *Head*: Moderately and evenly tanned; length 1.01-1.28 mm (mean = 1.13 mm); width 1.02-1.38 mm (mean = 1.18 mm). Dorsomen-tum heavily tanned, with 6 or 7 short blunt teeth on either side of slightly larger median tooth. Seta 1-C spiculate apically; 15-C forked or branched distally. *Antenna*: Moderately and evenly tanned; length 0.25-0.33 mm (mean = 0.28 mm). Setae 2-A single. *Thorax*: Integument hyaline, smooth. Setae 5,7, 9,10-P and 7,9,13-T with many distinctly aciculate branches, other thoracic setae normally with simple branches; 14-P always single; 14-M always branched. *Abdomen*: Integument hyaline, smooth; segments I-VII each with prominent

midventral lobe, lobes become more caudal in position and project more strongly caudad on successive posterior segments. Setae 6-I,II,VI, 1-VI,VII, 3-VIII and siphonal setae with distinctly aciculate branches; other abdominal setae normally with simple branches; seta 11-VII anteromesal to 10-VII; 13-VII always single. *Segment VIII*: Comb with 5-13 (mean = 9) short pointed scales with minute fringe of spicules on sides at base. *Siphon*: Moderately tanned, surface smooth; long, slightly bent distally, length 1.07-1.40 mm (mean = 1.25 mm), width at base 0.21-0.36 mm (mean = 0.28 mm), index 3.94-5.40 (mean = 4.50). Anterior margin with 18-25(23) fanlike setae with 5-13(9) branches, distal setae with fewer branches, longest setae about twice diameter of siphon; posterior margin with 24-30(29) fanlike setae with 2-14(10) branches, distal setae with progressively fewer setae toward apex of siphon, longest setae about 3 times diameter of siphon. *Segment X*: Saddle moderately pigmented, length 0.25-0.37 mm (mean = 0.30 mm); siphon/saddle index 3.65-

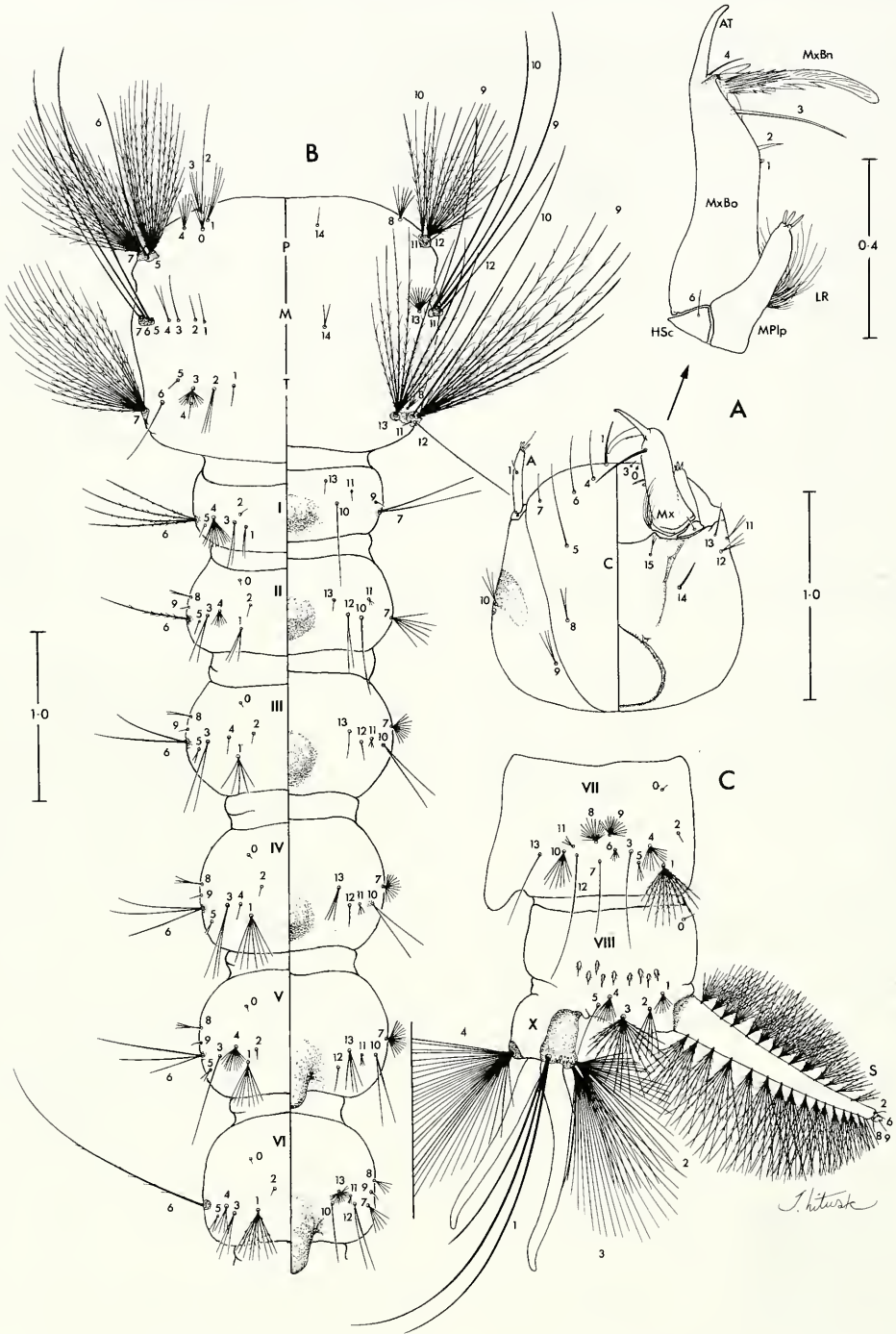


Fig. 3. Fourth-instar larva of *Kimia decorabilis*. A, Head, dorsal (left) and ventral (right) aspects of left side; enlargement of right maxilla, ventral aspect. B, Thorax and abdominal segments I-VI, dorsal (left) and ventral (right) aspects of left side. C, Abdominal segments VII-X, left side. A, antenna; AT, apical tooth; C, cranium; HSc, hypostomal sclerite; LR, laciniarastrium; M, mesothorax; MPp, maxillary palpus; Mx, maxilla; MxBn, maxillary bundle; MxBo, maxillary body; P, prothorax; S, siphon; T, metathorax; I-VIII, X = abdominal segments I-VIII and X; 1-15 = setal numbers for specified areas, e.g., seta 6-Mx. Scales in mm.

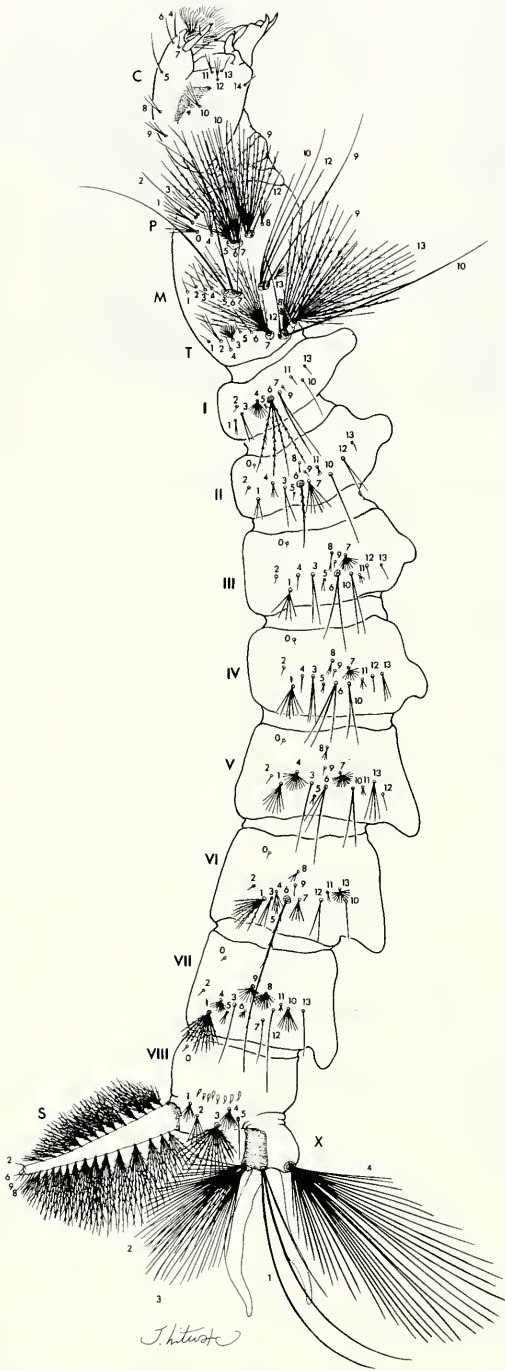


Fig. 4. Fourth-instar larva of *Kimia decorabilis*, lateral view of right side showing the prominent midventral lobes of the abdominal segments. Abbreviations and numbers as in Fig. 3.

4.80 (mean = 4.15); dorsal and ventral anal papillae long, slender, tapered, more or less equal length.

Discussion.—Based on similarities in male genitalia, *Km. decorabilis* appears to be more closely related to allopatric *Km. imitata* (Philippines) than to the other three species of the genus. The holotype male of *Km. imitata* (the only known specimen) and its associated larval exuviae were examined, but the male and larval exuviae are in poor condition and could not be studied in detail. It is obvious, however, that the larva of this species differs from the larva of *Km. decorabilis* in having a shorter, spiculate siphon with fewer dorsal (12) and ventral (about 20) setae. The setae have fewer branches and those on the ventral margin are much longer (more than twice as long) than those on the dorsal margin. A rather superficial examination of the pupal exuviae did not reveal any obvious distinctions. The male genitalia differ from those of *Km. decorabilis* in having three rodlike setae on the basal mesal lobe and a very short, distally expanded, clublike gonostylus. A dense cluster of long, curved setae on the basal mesal lobes of *Km. nemorosa* and *Km. suchariti*, and the long narrow and flexible gonostylus and row of stout setae on the basal mesal lobe of *Km. miyagii*, easily distinguish the males of these species from those of *Km. decorabilis* and *Km. imitata*. Larvae and pupae of the first three species were not available for study and the original and only descriptions and illustrations of these life stages lack details that might distinguish them from one another and the other two species. It would be interesting to know whether the larva of *Km. decorabilis* is unique in having prominent midventral lobes on the abdominal segments. Except for *Km. nemorosa*, larvae of the other species were described from the exuviae of reared specimens. According to Gong (1996), the type series of

Km. nemorosa includes both larvae and larval exuviae, and his illustration of abdominal segments VII–X in lateral view appears to have been drawn from a larva. The most notable feature of this illustration is what appears to be a small lobelike expansion on the ventral side of segment VII.

Bionomics.—Larvae of *Km. decorabilis* are found in green, upright bamboo internodes that bear small holes presumably made by beetles. Specimens from northern Vietnam were collected alone or in association with unidentified *Topomyia* larvae from small-stem bamboo (cavity diameter of 2–3 cm) of genera *Maclurocheoa*, *Phyllostachys*, and *Schizostachyum* (Vu Duc Huong personal observation). The specimens were provided with larvae of *St. aegypti* while being reared in the laboratory. The larva used principally to draw Figs. 3 and 4 was found along with larvae of *Aedes* Meigen, *Anopheles (noniae)* Reid, and *Topomyia* in an internode of *Dendrocalamus* bamboo with a diameter of approximately 10 cm. This larva, apparently now lost or misplaced in the Smithsonian Institution (R.C. Wilkerson personal communication), was collected in Perak State of peninsular Malaysia on 8 January 1988 by Mohd Nohr and Bruce A. Harrison, who made the following observations while attempting to rear the larva in captivity. The larva was fairly sessile, moved slowly about by twisting, and rested on the midventral abdominal lobes while opening and closing its maxillae (and mandibles) in the debris on the bottom of the rearing container. The maxillary bundles were observed to lift debris from the substrate to the proximity of the mandibles. The long setae 6–VI were held outward and downward in touch with the substrate, and thus served as stabilizers to keep the larva from tilting from side to side. The larva was not seen to come to the surface for air.

Distribution.—Disregarding the questionable record of *Km. decorabilis* on Borneo (Edwards 1932), before now this species was only definitely known to occur in Selangor State of peninsular Malaysia (based on the type specimens and others in the NHM). The present study is based in part on specimens collected in northern Vietnam (see below), which significantly extend the range of this species and suggest that it is probably widely distributed in mainland areas of Southeast Asia.

Material examined.—Fifty-five specimens (7♂, 5♀, 6♂G, 1♀, 15Le, 13Pe, 7L), including 10 individual rearings. Lectotype ♂, with dissected genitalia on acetate strip on pin, MALAYSIA: *Selangor*, The Gap, in jungle, 24 Apr 2004; paralectotype ♀, same locality as lectotype, 14 April 2004 (NHM). MALAYSIA: 1LePe♂ (0353/9), 1♀LePeG (0353/1), *Selangor*, Ulu Gombak, 16th mi., 8 Oct 1957; 1LePe♂G (0391/4), same locality, 5 Nov 1957; 1♀LePe (0534/1), same locality without mile, 12 Mar 1958. VIETNAM: 1LePe♂G (BC1), 1♀LePe (BC2), *Bac Kan Province*, Cho Don District, Binh Trung Commune, 150 km north of Hanoi, bamboo internode, 17 Jun 2005 (*Vu Duc Huong & Nguyen Thi Bich Lien*). 2LePe (nos. 4 and 5, 2♂ destroyed), *Bac Thai Province*, Phu Luong District, Thanh Mai Commune, Apr 1982 (Vu Duc Huong et al.). 1L, *Ha Son Binh Province*, Kim Boi District, Thuong Tien Commune, Oct 1981 (Vu Duc Huong et al.). 1L, *Ha Tuyen Province*, Bac Quang District, Tan Lap Commune, Aug 1979 (Vu Duc Huong et al.). 1LePe (no. 3, adult ♀ destroyed), *Hoang Lien Son Province*, Van Yen district, Dong Cuong commune Sep 1980 (Vu Duc Huong et al.). 3LePe♂G (TN1, with head on microscope slide; TN3; TN16), 1♀LePe (TN2, with head on microscope slide), 2Le (TN4; TN5), 5L (TN8–TN12), *Thai Nguyen Province*, Dinh Hoa District,

Qui Ky Commune, 150 km north of Hanoi, bamboo internode, 14–16, 18 Jun 2005 (*Vu Duc Huong & Nguyen Thi Bich Lien*). 1Le♂G (no. 1), *Thanh Hoa Province*, Luong Ngoc District, Quang Hien Commune, May 1980 (*Vu Duc Huong et al.*).

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2. *Occipital foramen*: circular to oval (0).
 3. *Maxillary palpus*: appended to maxillary body (0).
 4. *Hypostomal sclerite*: detached from lateralia (2).
 5. *Hypostomal sclerite and maxillary palpus*: separate (0).
 6. *Hypostomal sclerite and maxillary body*: separate (0).
 7. *Apical tooth of maxilla*: present (1).
 8. *Maxillary brush*: represented by a flexible bundle of coalesced spicules (1).
 9. *Seta 2-C*: absent (0).
 10. *Seta 3-C*: present, on oral surface of head (1).
 11. *Seta 13-P*: absent (0).
 12. *Seta 8-M*: absent (0).
 13. *Seta 1 on some or all of abdominal segments I–VII*: with normal stemlike branches (1).
 14. *Setae 6,7-I,II*: one or more main stems without plumose branching (1).
 15. *Seta 12-I*: absent (0).
 16. *Seta 5-VIII*: close to seta 4, usually near or above level of dorsal margin of segment X (1).
 17. *Comb*: present (1).
 18. *Comb plate*: absent or weakly developed (0).
 19. *Siphon* (degree of development): elongate fully sclerotized tube (3).
 20. *Seta 1-S*: inserted beyond base of siphon (1).
 21. *Pecten*: absent (0).
 22. *Accessory setae of siphon (other than 1,2-S)*: present (1).
 23. *Saddle*: incomplete (1).
 24. *Pairs of seta 4-X*: one pair (1).

APPENDIX

Anatomical characters used in the cladistic analysis. See Harbach and Kitching (1998) for coding and discussions of the characters. Character states observed in *Kimia* are listed with the numerical character code of Harbach and Kitching in parentheses.

Larvae (fourth-instars)

1. *Hypostomal suture*: complete to posterior tentorial pit (1).

Pupae

25. *Dorsal apotome*: weakly sclerotized medially, appearing as two sclerites joined by membrane (1).
26. *Trumpet*: supporting tubercle absent (0).
27. *Tracheoid area of trumpet*: absent (0).
28. *Seta 1-CT* (degree of development): very strongly developed, considerably larger than setae 2,3-CT (2).

29. *Seta 14-III-VII*: absent (0).
30. *Seta 9-IV-VII*: removed from caudolateral angle of tergum (1).
31. *Seta 0-VIII*: inserted on anterior area of tergum (0).
32. *Seta 9-VIII*: ventral in insertion (0).
33. *Seta 14-VIII*: absent (0).
34. *Seta 1-IX*: absent (0).
35. *Seta 1-XI*: absent (0).
36. *Paddle seta(e)*: absent (0).
- Adults* (both sexes except where otherwise indicated)
37. *Erect scales of head*: absent (0).
38. *Interocular space* (principally females): constricted, without scales/setae extending to postfrontal sutures (0).
39. *Interantennal ridge* (females): incomplete in dorsal area of postfrons, with frontal pit reinforced by cuticular ring associated with postfrontal sutures (2).
40. *Interantennal ridge* (males): incomplete (absent) in postfrons (1).
41. *Basal microsetae of antennal pedicel*: present (1).
42. *Apical flagellomeres* (males): these flagellomeres not disproportionately long in comparison with the others (1).
43. *Maxillary palpomeres* (females): two, third vestigial if present (3).
44. *Maxillary palpomeres* (males): two, third vestigial or absent (3).
45. *Mouthparts*: long, developed into a proboscis (1).
46. *Labellum*: comprising two separate sclerites (0).
47. *Proximal sclerite of labellum*: short, similar in size to distal sclerite (1).
48. *Labellar scaling*: present (1).
49. *Anteppronota*: smaller (usually) and more widely separated (1).
50. *Acrostichal setae*: absent (0).
51. *Dorsocentral setae*: absent (0).
52. *Scutellum*: trilobed (1).
53. *Mesopostnotal setae and/or scales*: absent (0).
54. *Paratergite*: bare (0).
55. *Postpronotal setae*: present (1).
56. *Prespiracular setae*: present (1).
57. *Postspiracular setae*: absent (0).
58. *Prealar setae*: present (1).
59. *Upper mesokatepisternal setae*: absent (0).
60. *Lower mesepimeral seta(e)*: absent (0).
61. *Metepisternal scales*: present (1).
62. *Upper calypter*: bare (0).
63. *Vestiture of alula*: present (1).
64. *Vein R_s with basal spur*: absent (0).
65. *Vein R_2* : equal or longer than vein R_{2+3} (1).
66. *Precubital furrow*: absent (0).
67. *Anal vein*: ends beyond junction of mcu and CuA (1).
68. *Microtrichia of wing membrane*: distinct, clearly visible at low magnification (1).
69. *Tarsomere 1 of fore- and midlegs*: shorter than tarsomeres 2-5 combined (0).
70. *Base of hindcoxa*: more or less in line with or slightly above dorsal margin of mesomeron (1).
71. *Pulvilli*: absent or rudimentary (inconspicuous) (0).
72. *Spermathecal capsules* (females): three (1).
73. *Paraprocts* (males): strongly developed, apex without crown of spicules (1).